22995

IGM 84-000-108
Etude No. 108

ORIENTATIONS DE RECHERCHE POSSIBLES DANS LE DOMAINE DES VERRES ET CERAMIQUES A L'IGM.

J.J. HECHLER

Le 1 mars, 1984

CNRC 22995

I.) Travaux du Comité Consultatif Ad-hoc sur les céramiques.

Introduction:

Ce Comité a été créé en début de 1981 avec pour mission de conseiller l'IGT sur des orientations possibles de recherches sur les Céramiques à l'intérieur de son mandat. Les réunions du Comité ont eu lieu entre avril et septembre 1981. Plusieurs réunions de discussions en comité-restreint ont eu lieu par la suite pour éclaircir certains points et le Président du Comité devait rendre le rapport final pour le début de 1982. Une dernière réunion partielle avec les représentants de l'industrie verrière a eu lieu fin août 1983 pour permettre enfin la rédaction finale du rapport. Malgré cela et de nombreux rappels de ma part, ce rapport final n'est toujours pas disponible. La présente synthèse doit donc le remplacer. En annexe, figurent les comptes-rendus des différentes réunions avec la liste des participants. (Annexe I).

Les différentes orientations de recherches ont été identifiées pour les trois catégories de produits suivants:

- les verres
- les réfractaires
- les produits à base d'argile.

s bétons et les céramiques fines n'ont pas été considérés.

Les verres.

rientations possibles sont les suivantes:

1.1) Etudes des propriétés mécaniques:

Ces propriétés intéressent toute l'industrie du verre, (contenants, verre plat, fibre de verre). Il y a notament peu d'études, surtout au Canada, qui portent sur la mécanique de la rupture du verre contrairement aux métaux et alliages. Il y a un net besoin pour l'industrie verrière des contenants, de produire des bouteilles plus résistantes aux chocs. (Ex: études récentes d'implantation d'ions à la surface des bouteilles pour augmenter la résistance mécanique du verre, par modification de structures et des propriétés de surface).

1.2) Revêtements

1.21) Revêtements sur le verre:

De tels revêtements sont principalement utilisés pour augmenter la résistance mécanique des contenants en verre. Le produit actuellement utilisé est $SnCl_4$ pour l'obtention d'une couche de SnO_2: ce produit est actuellement très cher et cause de nombreux problèmes d'environnement. Des produits de remplacements sont souhaités (Ex: silicones, TiO_2, revêtements organiques,...).

1.22) Revêtements des équipements de production.

- L'abrasion des aciers ordinaires, par les fibres de verre est un problème sérieux dans cette industrie. Des revêtements adéquats réduiraient la dégradation de ces aciers.

-Les agents démoulants sont utilisés dans les moules de production des bouteilles. Outre le problème d'environnement qu'ils causent, ils ralentissent la production. Des revêtements adéquats durables à l'intérieur des moules sont ainsi souhaitables.

1.3) Electro-fusion du verre.

1.31) Ce type de production du verre intéresse actuellement au Canada uniquement Fiberglass. Si ce type de four présente des avantages (meilleur rendement énergétique, pas de problème d'environnement), il présente l'inconvénient de réduire d'un facteur de trois la durée de vie des réfractaires utilisés par une érosion-corrosion plus importante. Des recherches dans le but de diminuer cette dégradation est souhaitée.

1.32) Autre possibilité d'études: amélioration des matériaux d'électrodes qui sont rapidement corrodés.

2.) Les réfractaires.

Aucun type particulier de réfractaires n'a été considéré - seules des orientations générales de recherches sur les réfractaires ont été discutées.

2.1) Mise en valeur de minérais canadiens.

Bien que l'étude de la mise en valeur des minérais n'est pas dans le mandat de l'IGM, l'IGM pourrait néanmoins envisager le développement de nouveaux produits en collaboration avec EMR, par exemple - qui auparavant auraient été évalués convenablement pour leur intérêt industriel.

2.2) Banque de données.

Les informations concernant un réfractaire donné sont très souvent contradictoires. Toutes les informations disponibles (industrie, manufacturier, essais en laboratoires...) pourraient être stockées et évaluées de façon critique.

2.3) Erosion-corrosion

Toute étude visant à diminuer cette dégradation est utile, par example: étude de diagrammes de phases correspondants à des systèmes réels, étude des mécanisme et de la critique de dégradation, etc.

2.4) Conductivité thermique.

Il n'y a pas d'équipements au Canada qui permettent de mesurer la conductivité thermique de réfractaires au-dessus de 1000°C. Les aciéristes canadians semblent très intéressés par de telles mesures (voir annexe 2).

2.5) Essais non-destructifs - (NDT).

De tels essais seraient utiles pour l'évaluation des réfractaires avant leur utilisation par les acieries et l'industrie verrière.

Ex: essais acoustiques et ultrasoniques - (voir annexe 3). Des informations concernant une masse volumique non-uniforme, des fissures,... limitant leurs utilisations pourrait être développées.

3.) Produits argileux.

3.1) Cordiérite.

Ce matériau a été retenu car ses trois composants sont disponibles au Québec (MgO, Al_2O_3, SiO_2...). Ce matériau est intéressant par son faible coefficient d'expansion thermique ce qui permet une utilisation, entre autres, pour des tuyaux de cheminées, et sa forte capacité-thermique pour l'utilisation en stockage de chaleur. Une étude et une proposition de recherche a été faite en collaboration entre ORF et CRIQ.

3.2) Toxicité des glaçures.

L'étude et l'amélioration de la stabilité de glaçures contenant du plomb et divers colorants sont en cours d'études à l'IGM et à l'ORF.

II.) Quelques sujets de recherches suggérées par les activités de la division de l'energie.

Ces activités sont gérées presque exclusivement par contrats donnés aux Universités et Industries Canadiennes et sont considérées comme priorité nationale. La Division de l'Energie souhaite une participation plus active des autres divisions du Conseil dans ses activités.

Les possibilité de recherches dans ce cadre pourraient être:

1) Développement de matériaux céramiques pour les collecteurs de courant dans les batteries à haute performance à hautes températures en milieu de sels fondus.

Ce type de batteries (FeS/LiAℓ) fonctionant à 450°C en milieu fondu de LiCl-KCl est développé à l'IREQ. Un projet conjoint IGM - IREQ no 157 (Corosion des matériaux d'électrodes dans les batteries expérimentales) avait été initié en mai 1981 puis mis en veilleuse par manque de temps. Ce projet pourrait être repris.

2) Un type de matériaux d'électrode prometteur, agissant également comme catalyseur, pour les cellules d'électrolyse de l'eau dans la production d'hydrogène sont les perovskites (Ex: $La_xSr_{1-x}Co\ O_{3-y}$). Ces composés ont été étudiés par l'Université de Halifax de façon peu exhaustive. Une participation à ce projet avait été souhaitée par la Division de l'Energie par suite de l'instrumentation (projection plasma) disponible à l'IGM.

3) Technique "sol-gel".

Cette technique utilisant un intermédiaire polymérique permet de produire des matériaux habituellement obtenus par fusion (verres) à des températures plus basses (économie d'énergie) ayant des propriétés améliorées (meilleur homogénéité, grains très fin, grandes latitudes de composition).

Cette technologie est à présent mise en oeuvre pour la fabrication d'une classe nouvelle de matériaux: Les aérogels. Ces matériaux, comportant des micropores, sont très légers et ont un gros coefficient d'isolation thermique. Un contrat a été passé avec l'Université du Manitoba pour la réalisation de vitrage isolants.

III.) Les céramiques fines.

Deux rapports ont récemment circulé à l'IGM ("Japanese developments in areas of advanced Industrial Materials" de C.M. Chihrin et " Assesment of the needs and opportunities in advanced materials technologies" de Hatch Associates Ltd.).

Ces deux rapports font resortir l'incroyable développement au Japon et l'inactivité totale du Canada dans le domaine de ces nouveaux matériaux. Dans le cadre de la mise sur pied à l'IGM d'un programme de céramique, ces deux rapports mériteraient d'être considérés.

J.J. Hechler

JJH/gl

ANNEXE I

AD HOC ADVISORY COMMITEE TO NRCC/IMRI

ON CERAMICS

Minutes of the first meeting
Friday April 3rd 1981

K. Bell	President
K. Murthy	Member
F. Dugal	Member
P. Chollet	Member
J.J. Hechler	Secretary
S. Dallaire	Observer

MAIN POINTS

1. P. Chollet recalled in a few words why this Commitee has been created.

2. K. Bell proposed for the agenda of the meeting to review the following documents:

   2.1 Symposium on R & D needs of Canadian glass, ceramic and allied industries in the eighties.

   2.2 An evaluation of needs and opportunities for fruitful fundamental research in Ceramics. (J.B. Watchman et al.).

   2.3 R & D problems of current interest to the Canadian Glass Industry. (K. Murthy)

   2.4 Preliminary report by Warnock-Hersey, study sponsored by IMRI. (R. Farsky)

   2.5 List of ceramics-related research topics suggested to IMRI. (P. Chollet)

   2.6 CSIRA's technological barriers or challenges.

   2.7 Annual Report for 1980 ISO/TC 33 (excepts).

   2.8 Non-destructive evaluation of refractories (K. Murthy)

3. Review of document 2.1

The following applications have not been retained:

- Ceramics for electronic applications.
- Optical filters.
- Insulation materials (within the mandate of BRD).

Applications which might be interesting to IMRI:

- Ceramics for heat storage.
- Refractories as used in the steel and glass industry.

Two important fields of research in refractories are:

- Studies of the performance of refractories in service (degradation, corrosion, etc...). These phenomena are not well understood due to the lack of phase diagrams (refractories - melts).

.../2

- Studies of standard tests for refractories.

  The tests commonly used do not take account of how refractories are used. Some of these tests proved to be ineffective and need to be replaced. K. Bell is involved in a ISO Commitee working on size standardization and points out the absence of Canada in all the other commitees. To do research on standard tests would allow Canada to gain considerable experience and to be able to participate actively in the international scene in these ISO commitees.

4. Review of document 2.2

   Two tables in this paper are important:

   TABLE 1: Enumerates various subfields in which IMRI will have to be active in its ceramic program.

   TABLE 2: Enumerates some energy application of ceramics. Storage batteries seems to be the only application of interest to IMRI.

5. Review of document 2.3

   Interesting topics:

   - Refractories
   - Strength of glass
   - Electric melting of glass

6. Review of document 2.4

   Interesting topics:

   - Studies of reactions between refractories and slags under various atmospheres in ferrous and non-ferrous metal industries.

   - Studies of aging mechanisms of refractories and their monitoring (i.e. localize hot spots by I.R.) on site.

   - Non destructive testing.

7. Summary of subjects of interest to IMRI (from all documents reviewed, or suggested during the meeting).

   - Ceramics for heat storage
   - Refractories in service (degradation and corrosion)
   - Phase diagrams (refractories - slags, refractories - melts, ...)
   - Studies on ceramics testing
   - Standard tests
   - New tests
   - N.D.T.

- Glass coatings
- Strength of glass
- Electric melting of glass
- Raw materials studies, body development for special applications
- Topics suggested to IMRI (cf. list by P. Chollet).

8. Decisions

8.1 The commitee will study this list, prepare comments and think of experts who might be contacted.

8.2 This list will be reduced to a few topics and the experts invited by the commitee in order to define precise projects. These projects will be short or medium term projects in order to give IMRI time to develop its expertise.

9. Schedule of next meeting

The next meeting is scheduled for April 30th, 1981 at the Centre de Recherche Industrielle du Québec (C.R.I.Q.) in Quebec City, at 10:00 a.m.

Jean-Jacques Hechler
Montreal, April 14th, 1981

JJH/gs

AD HOC ADVISORY COMMITTEE TO NRCC/IMRI

ON CERAMICS

MINUTES OF THE SECOND MEETING

THURSDAY, APRIL 30th 1981

PERSONS PRESENT

K. Bell	President
K. Murthy	Member
F. Dugal	Member
P. Chollet	Member
J.J.Hechler	Secretary

1. Review of P. Chollet's list of projects submitted to IMRI and comments.

a) Project No. 031: cordierite (CRIQ)

Cordierite is important for:

- its low thermal expansion coefficient (utilization for ovens, tableware, ...)
- High heat capacity (SiO_2 -MgO modified body used for heat storage.)
- its three components available in Quebec along with energy.

An 18-month IGM project on cordierite might lead to a useful product. The different phases involved in such a research will be:

- Development of a body composition
- Study of fracture characteristics
- Study of thermal conductivity
- Structural studies

F. Dugal will submit a more elaborate proposal on cordierite.

b) Project no. 029, Mullite (CRIQ)

Mullite is less important than cordierite, and is mainly used for its highly abrasive properties. The natural world reserves are very small and all Mullite used in Canada is imported.

c) Project No. 032 - Foam clays

Foam clays with open cells are used for their accoustic properties (sound absorption coef. of 0.8). Foam clays with closed cells are used for their insulating properties. (8' x 2' x 6" slabs.)

d) Project No. 097 - Thermal conductivities

Thermal conductivities change with time and with corrosion. The EMR thermal conductivity equipment allows measurements to be made up to 1000° C. Alcan expressed its need for an equipment for higher temperatures. It should be interesting to know similar needs in other industries, the steel industry, for example, before going ahead in this project.

e) Project No. 165 - Chrome-magnesia bricks

Submitted by Ecole Polytechnique, this project could be a good start for a short term study.

2. Other subjects discussed.

a) Light weight aggregates:

High energy prices make them less important. They are used in the construction industry in order to reduce the weight of the structures.

b) Clay products

In chimneys stainless steel is used as a liner. In order to keep their price low, a small thickness is used which cannot stand a chimney fire. If this thickness has to be increased, then ceramics become competitive. (Ex: cordierite for its low expansion coefficient and its good resistance to humidity.)

c) Resistance of bricks to freeze-thaw cycles.

d) Electric melting of glass.

The problems are mainly practical problems (electrodes dimensions , their position ...). It is necessary to have the opinion of an expert to decide if IMRI should be active in this field.

3. Partial list of the basic equipment needed.

Grinding equipment

Mixers

Hydraulic press

Extruder

Dryers

Kilns

Thermal expansion equipment

Temperature gradient oven

SEM with XRF attachment

Optical microscope

etc.

5. K. Bell and K. Murthy will provide IMRI with a list of books for its library.

6. The different projects and proposals reviewed are separated in three categories - refractories, glass, clay products. The Committee agrees to have one separate meeting with experts for each category.

7. List of subjects reviewed during the first two meetings:

a) Refractories:

- Ceramics for heat storage
- Refractories in service (degradation and corrosion)
- Ceramics testing (standard tests, new tests, N.D.T.)
- Phase diagrams (refractories - slags, refractories - melts)
- Thermal conductivities measurements
- Chrome-magnesia bricks

b) Glass:

- Glass coating
- Strength of glass
- Electric melting of glass

- Fatigue of glass

c) Clay products:

- Raw materials studies, body development (cordierite, Mullite)
- "Mousse d'argile et thermomousse"
- Lightweight aggregates
- Clay chimney liners
- Freeze-thaw problems of bricks.

8. The next meeting will be held at ORF on June 16th, 1981, tentatively. This will be the meeting on refractories. IGM will invite J. Perry (Canadian Refractories Ltd.), an expert for the steel industry and M. Rigaud, Ecole Polytechnique, Montréal.

J. J. Hechler

JJH:ml

13/05/81

AD HOC ADVISORY COMMITEE TO NRCC/IMRI

ON CERAMICS

Minutes of the third meeting
Thursday June 18th 1981

PERSONS PRESENT

J. Perry	Canadian Refractories
J. Beauchemin	Ciments Canada Lafarge
K. Bell	President
K. Murthy	Member
F. Dugal	Member
J. J. Hechler	Secretary

I) Study of raw materials

Nearly all raw materials for ceramics are imported. Raw materials are available in Canada but are of a low-grade quality.

Problems related to these raw materials:

- An organisation will have to be created to develop those new materials (the cooperation between CRIQ and SNA to develop subproducts in the Asbestos industry is an example).
- Purification, mill-dressing, etc...to be done. (by CANMET, for instance)
- Refractories made out of these materials will have to be evaluated for their profitability (downtime, labor, productivity)
- Customers will not accept easily to change the current high-grade refractories.
- The current trend is to raise the process temperature, and this is not in favor of utilisation of low-grade materials. (although water cooled refractory panels made out of low-grade materials can be used.)

There is nevertheless an oppurtunity for IMRI to be active in this field: by

- Looking for replacement products using low-grade materials.
- Developing such products in its laboratories.

II) Data Bank and statistics

Very little information is available on currently used products. Statistics on life-time of refractories have been made only during the last years by the users. Life-time guaranties are neither asked for by the customers nor given by the producers.

This data bank will be made up from:

- Information gathered from IMRI studies on the various projects initiated by industries. The refractories will have to be well characterised.
- Information on actual performance from industries.

Such a data bank would be useful:

- for the selection of refractories
- for develop' replacement products (cf. point 1.)

III) Phases involved in the study of refractories

1.) Study on phase diagrams

- Phase diagrams resulting from the components in useful compositions
- Phase diagrams involved when the refractory is corroded and degraded by the melts, slags, various atmospheres, etc...

2.) Study of chemical properties

- Corrosion, erosion, dissolution : their mechanism and their kinetics
- Chemical properties of the melts and the slags

3.) Study of physical properties

- Service temperature limit
- Microstructure (micro-phases, grain boundaries, imperfection)
- Corrosion and erosion
- Porosity(pore-size distribution, permeability.)
- etc...

4.) Study of thermal properties (at operating temperatures)

- Thermal conductivity
- Thermal expansion (studies of change of structure)
- Heat capacity
- Thermal shock resistance
- PCE (pyrometric cone equivalent)
- Etc...

5.) Study of mechanical properties

- Elastic modulus
- Deformation under load (at high temperature)
- Creep (high temperature)
- Etc...
- Compressive strengh

6.) Post-mortem examination

VI) Opportunities of research in testing

- Slag testing: this test gives information on the resistance of the refractories towards slags. The current test being done at constant temperature is indequate since in plant operation there is a temperature gradient in the refractories. In particular the slag penetration in the refractories is not the same.

- NDT.

  Detection of non-uniform density
  Detection of cracks
  Detection of horizontal lamination

  by ultrasonic or sonic methods for quality control by producers or users (cf. document submitted by K. Murthy)

- Thermal conductivity at high temperatures

- Participation to ISO as a Canadian member.

V) Specific project suggestion

In all case of failure, a crack appears on the back-end of the bricks as a result of the slag penetration. A contribution to the knowledge of these phenomena could be a good project.

VI) Additional information

1.) Thermal conductivity measurements of refractories at high temperature.

A short report submitted by K. Murthy shows that Stelco, Dofasco and Algoma Steel are very interested to have such a facility in Canada.

It will also be a useful instruments in the future activities on refractories at IMRI.

2.) K. Murthy and F. Dugal provided two lists of books on ceramics of interest for IGM library.

J. J. Hechler.

JJH/gs

AD-HOC ADVISORY COMMITEE TO IMRI/NRC ON CERAMICS

Minutes of the 4th meeting July 17th, 1981

Persons present:

B. Muschala	Consumers glass Co.
B. May	Consumers glass Co.
G. Anderson	Dominion glass Co.
D. Prohaska	P.P.G. Insustries Canada.
K. Linger	Fiberglass
K. Bell	President
F. Dugal	Member
K. Murthy	Member
P. Chollet	Member
J.J. Hechler	Secretary

This meeting was held with representatives of the Canadian glass Industry in order to define opportunities of research in glass within the mandate of I.G.M.

The following fields of research were discussed:

A) Refractories

1. Disposal of chrome bricks

Chrome bricks are used in the regenerators. In the US, these bricks must be disposed of according to very strict environmental laws. This is not yet the case in Canada but the glass industry expects similar laws in Canada in the very near future.

The research possibilities are:
- the reuse of these bricks
- developping a replacement product

2. Erosion - Corrosion of refractories

The normal lifetime of refractories in the glass industry is about 10 (ten) years. The corrosion at the molten glass level is about 2" for the first year, 5" for the first two years and about 8-10" after 10 years. This corrosion is enhanced by impurities and foreign materials coming from recycled glass (culed).

This problem of erosion - corrosion is also enhanced by electric boosting in the melting of glass. This problem is even greater for Fiberglass which uses only electric melting.

One solution to lower this attack is to use chrome bearing bricks, but their thermoshock properties are poor.

B) Strength of glass

Strength of glass studies are important for the whole glass industry (glass container, flat glass, glass fibers where the mechanical properties of insulating products are heavily influenced by the production process).

There is lack of basic knowledge in the field of strength and fracture of glass. Research is being done in fracture mechanics for metals and alloys but seldom for glass. It should be interesting for I.G.M. to be active in this field since not much work is done in Canada.

One possibility of strengthening glass which was mentioned is chemical strengthening of glass (addition of foreign ions changing the glass network and the surface properties).

.../2

C) Coatings

1. Coating on glass

Coatings on glass are used mainly to improve the strength of glass.

- SnO_2: this coating is expensive, with environment problems. There is a need for replacement products.

- Silicones, T_iO_2, organic coatings.

2. Coating on equipment used in the glass industry

- Abrasion of common steel in contact with glass fibers is a serious problem. A coating of steel might reduce this abrasion.

- A coating inside the molds (used for instance in the production of bottles) might minimize or suppress the use and the environmental problems of a demolding agent (swabbing).

D) Electric melting

The glass fiber industry uses only electric melting furnaces. With this exception and the use of electric boosting, electric melting is only used for speciality glasses.

Some advantages of electric melting are:

- Higher energy ouput of the furnaces
- Less polution problems due to the borate glasses

Some disadvantages are:

- Furnaces are smaller: 160 t/d compared to 400 t/d for a gas furnace.
- 3 years lifetime for the furnaces instead of 10 years for the gas furnaces due to higher erosion - corrosion problems of the refractories.
- Corrosion problems of the electrodes.

E) Others

1. Instrumentation problems
   Temperature, CO_2, O_2, ... sensors in the melts corrode rapidly.

2. Design
   There is a need for better design for the molds (better heat transfer properties).

F) Next meeting

The next meeting in scheduled for August 17th, 10 a.m. at I.G.M., Montréal.

J.J. Hechler

JJH/gs

AD HOC ADVISORY COMMITTEE TO NRCC/IMRI

ON CERAMICS

Minutes of the fifth meeting
at IMRI Monday August 17th, 1981

Persons present:

K. Bell President
H. Marquis IGM
K. Murthy member
F. Dugal member
P. Chollet member
J.J.Hechler secretary

I) Review of the three categories of products

1) Clay products:
- Cordierite (project IGM no. 031)

K. Murthy and F. Dugal presented their project on cordierite aimed at the production of dinnerware,kiln ware, flue liners and related products having high temperature resistance and good thermoshock properties. This project involves EMR,IMRI, ORF and CRIQ at different stages. The participation of SNA (Société Nationale de l'Amiante, Quebec), was discussed. Pierre Chollet will inform SNA of the existence of this project.

- Lightweight aggregates

Very low priority is assigned to these materials since the production is very energy consuming. Due to this problem, new approaches to the fundamental study of these aggregates will have to be done.

- Freeze-thaw problems of bricks:

Such studies are rejected definitively, DBR doing work on this subject.

2) Refractories

H. Marquis stated that the users of refractories need much education (proper handling, proper operating practice, etc...) and that much saving is then possible.

- Data bank

In service information will be either hard to get or hard to interpret due to changing operating practices.

../2

- Study of phase diagrams

Again the importance of the nature of the atmosphere is reemphasized since it does not appear in these diagrams.

- Study of chemical properties

These studies will assess the proper use and the proper operating practice.

3) Glass

No new comments were made. It is important for IMRI now to decide for a program in glass as discussed at the fourth meeting with the Canadian Glass Industry representatives. IMRI has now been introduced by K. Murthy to this Industry and it is essential now to keep in contact through some in-house work.

II) Other topics

Discussion on how to begin research at IMRI.

The committee agrees that in order to gain credibility, IMRI will have to start research on very precise and limited projects, with a small group of researchers. Due to the lack of education available in these fields in Canada, some training of suited personnel will be necessary.

Each member of the committee will submit to K. Bell suggestions on:

1) Personnel required (education, experience ...)
2) Basic equipment to be bought by IMRI
3) Cooperation (Universities, industries..)

JJH/md

J.J. Hechler

Conseil national de recherches Canada
National Research Council Canada

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Reference File

8221-1

MINUTES OF THE MEETING HELD AT

ORF, August 29th, 1983

Persons present:

Dr. Levine	-	Dominion Glass
Dr. L. Gevaert	-	Consumers Glass
K. McCracken	-	Consumers Glass (lawer for)
K. Murthy	-	ORF
J.J. Bechler	-	IMRI

This meeting was held in order to obtain additional information of potential research in glass already identified in the 4th meeting of the ad-hoc committee on ceramics.

1) the representatives of the two glass companies were reluctant to discuss any problems especially concerning molds, coatings ... and no further information could be obtained.

2) an important part of the discussion was how IMRI could be useful to the whole canadian glass industry without requiring much information from them. A suitable way would be that the glass industry identifies some general areas of research that IMRI could then work on, starting form information available in the literature, if any interesting results were produced and possibly patented, they would then be discussed with the glass industry for eventual use.

3) three areas were mentioned which are of interest for both companies -

- Coatings on glass
  $SnCl_4$ used for obtaining SnO_2 coatings is very expensive and a replacement product is to be found.

- Repeatability and consistance of bottle molding.
  Research in new designs of molds with better heat transfer through new materials, coatings, swabbing products, ... and increased productivity.

- Strength of glass
  Production of a stronger bottle.

4) Dr. Levine and Dr. Gevaert would like to receive a copy of the final report for additional comments.

J.J. Hechler

J.JH:md

ANNEXE II

MEMO

ONTARIO RESEARCH FOUNDATION

SHERIDAN PARK RESEARCH COMMUNITY
MISSISSAUGA, ONTARIO, CANADA L5K 1B3 • (416) 822-4111 • TELEX 06-982311

June 16, 1981

To: Dr. M.K. Murthy

From: Mr. S. Johar

Subject: Thermal Conductivity of Refractories

I had discussions with the technical staff of three steel industries on the subject of setting up a high temperature thermal conductivity measurement setup for refractories. The following persons were contacted:

Mr. Arup Banerjee	-	The Steel Company of Canada, Hamilton, Ontario
Mr. J. Pierce	-	Dofasco, Hamilton, Ontario
Mr. R. Taylor	-	Algoma Steel, Sault St. Marie, Ontario

The following points were mentioned in the discussions.

1. There is no high temperature thermal conductivity measurement setup in Canada.

2. At present steel industries rely on:

   (a) Information from the manufacturers on their products.

   (b) Computer extrapolation of results from low temperature data.

   (c) Have samples experimentally evaluated in the United States.

3. It was felt that it will be very useful to have an independent Canadian source which can generate the data on high temperature thermal conductivity of refractories.

4. Setting up of such a system will be very useful to steel industries in Canada.

SJ/dc

ANNEXE III

The Ontario Research Foundation is presently involved in the evaluation of glass and ceramics using non-destructive testing. A high frequency ultrasonic surface acoustic wave setup is presently being used to detect surface cracks in Si_3N_4 and other structural ceramics, and a bulk wave setup will be ready in the near future.

Non-destructive techniques can also be applied to evaluate refractories. ORF would like to develop a NDE facility for evaluation of refractories as, there is a great need for their evaluation before these are installed in furnaces, especially in the steel and glass industries.

Our investigation shows that steel industries are in great need of such a system. Recent discussions with members of The Steel Company of Canada (STELCO), Hamilton, Ontario, brought out the following points:

(1) STELCO has $42 million worth of refractories in their inventory.

(2) They paid Dr. C. Samler of Ohio State University a considerable amount to evaluate their refractories using sonic and ultrasonic waves.

(3) The correlation between NDT data and destructive test data was good except in a few cases.

(4) The refractories are left on the ground for a considerable time. Hence, moisture content of refractories is not the same. This affects the interpretation of the NDE data.

In principle STELCO supports such a project.

S. Johar
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